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1 October 1992

RESEARCH INTERESTS

of the

AIR FORCE OFFICE OF SCIENTIFIC RESEARCH

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FOREWORD

Today the United States is second to none in military capability. This is the direct result of research and development carried out in the past; it has provided us the necessary technology for the present. The successful conclusion of Operation Desert Storm has been ample testimony to this.

Tomorrow's technological capabilities are derived from today's investment in research. The Air Force Office of Scientific Research (AFOSR) is charged with directing the Air Force's basic research program. This program includes both engineering and scientific research. The goals of this program are:

—to maintain technological superiority in the scientific and engineering areas relevant to Air Force needs

—to prevent technological surprise to our nation and create it for our adversaries

—to maintain a strong research infrastructure composed of Air Force laboratories, industry, and universities

—to complement the national research effort.

Through grants to university scientists, contracts for industry research, and support for basic research in Air Force laboratories, we form the base for future Air Force strength. Through these research programs, funded at about $200 million for Fiscal Year 92, we supported approximately 1,300 grants and contracts to about 350 academic institutions and industrial firms, and funded intramural research programs in the Air Force laboratories.

AFOSR also works closely with the Air Force laboratories to transfer extramural research results to the exploratory development programs of these laboratories. In addition, the laboratories participate in the process of selecting AFOSR research topics in areas of Air Force needs. To this end, we are encouraging those who prepare proposals to contact appropriate activities in the Air Force laboratories. The Directory section of this brochure provides some initial contact points to assist you in this.

This pamphlet will guide you in your efforts to participate in our research program. In order to facilitate the preparation of proposals, the pamphlet is divided into four sections:

The *Proposal Guidance* section describes the Broad Agency Announcement (BAA), the mechanism used by AFOSR to solicit research proposals. It also provides an overview of the general approach used to submit proposals.

The *Research Interests* section describes the basic research AFOSR is interested in sponsoring.

The *Education, Academic, and Industry Affairs* section discusses research assistantship programs, faculty programs, and graduate school programs. Most of these programs foster mutual research interests between the Air Force laboratories and institutions of higher education.

The *Directory* lists the names, telephone numbers, and addresses of AFOSR scientific directors and program managers, Air Force chief scientists, and Air Force laboratory task managers.

Anyone qualified to perform research is encouraged to contact AFOSR in accordance with the appropriate BAA and the guidelines given in this pamphlet. We particularly encourage contacts from Historically Black Colleges and Universities and other minority institutions.

Helmut Hellwig

HELMUT HELLWIG
Director

I

Proposal Guidance

The Air Force Office of Scientific Research (AFOSR) manages all basic research conducted by the US Air Force. To accomplish this task, AFOSR solicits proposals for research through various Broad Agency Announcements (BAAs) published in the *Commerce Business Daily* (CBD).*

Our General BAA outlines the Air Force Defense Research Sciences Program. AFOSR invites proposals for basic research in many broad areas. Section II of this pamphlet describes those areas in greater detail.

Specialized BAAs outline specific Air Force high-interest programs. Examples of recent BAAs include the University Research Initiative (URI) and Historically Black Colleges and Universities (HBCU) programs. HBCUs and minority institutions are those institutions determined by the Secretary of Education to meet the requirements of 34 Code of Federal Regulations (CFR), Section 608.2, and 34 CFR, Subpart 637, respectively. Portions of this pamphlet may be applicable to the research opportunities described in these specialized BAAs as well.

Each BAA specifies deadlines, proposal formats, and other unique requirements. Be sure to mark your proposal with the specific BAA number to ensure that it receives proper consideration. Information about current BAAs is available from the address below.

Proposals may be submitted on any topic listed in the particular BAA. You may submit separate proposals on different topics or different proposals on the same topic. The cost of preparing your proposal is not allowable as a direct charge to any resulting grant or contract. It is, however, allowable under the normal bid and proposal indirect costs specified in Federal Acquisition Regulation (FAR), 31.205-18.

The AFOSR *Proposer's Guide* (available separately) describes procedures to follow when submitting proposals. Unnecessarily elaborate brochures or presentations beyond those sufficient to present a complete and effective proposal are not desired. All proposals must be submitted in hard copy form directly to the office listed in the BAA.

Prior to submitting a research proposal, you may wish to contact the program manager at AFOSR. That person can provide certain information; however, in your conversations with any Government official, be aware that only contracting officers are authorized to commit the Government. Names and telephone numbers of AFOSR program managers are listed in Sections II and III of this pamphlet.

To obtain additional copies of this pamphlet or the AFOSR *Proposer's Guide*, send a self-addressed label with your request to

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General information can be obtained by calling (202) 767-4910. Department of Defense personnel can call DEFENSE SWITCH NETWORK (DSN) 297-4943.

This brochure as well as other AFOSR publications may be downloaded from the Federal Information Exchange (FEDIX), an on-line information system accessible via computer and modem. Call the FEDIX computer at (800) 232-4879. There is no charge to the user for accessing the information. The FEDIX helpline is (301) 975-0103.

* The CBD publishes synopses of proposed U.S. Government contract actions that exceed $25,000 in value. Subscriptions to the CBD are available from the Superintendent of Documents, Government Printing Office, Washington, DC 20402-9371, Tel. (202) 783-3238.

II

Research Interests

AEROSPACE SCIENCES

Structural Dynamics, Dr. Wu
Mechanics of Materials, Dr. Jones
Particulate Mechanics, Maj. Lewis
Structural Mechanics, Dr. Chang
External Aerodynamics and Hypersonics, Dr. Sakell
Internal Fluid Dynamics, Maj. Fant
Turbulence Prediction and Control, Dr. McMichael
Unsteady and Separated Flows, Maj. Fant
Airbreathing Combustion, Dr. Tishkoff
Space Power, Dr. Birkan
Aeropropulsion Diagnostics, Dr. Tishkoff

Research in aerospace sciences addresses fundamentals of solid mechanics and structures, fluid mechanics, and propulsion. The goal of the research programs is to develop science-based knowledge for Air Force weapons systems (aircraft, missile, and space platforms) and facilities applications. The investment strategy strives for coherency and balance among three areas—scientific merit, Air Force relevancy, and critical technology thrusts in areas where major advances in basic technology can be achieved through AFOSR investment.

Structural Dynamics

This research is to improve understanding of dynamic behavior in aerospace structures, seeking advanced concepts for predicting the aeroelastic instabilities, and development of new integrated structural control models to enhance the performance of future aerospace systems.

The program emphasizes the stability and control of structures subjected to aerodynamic, gust, and thermal loads and complex interactions with fluids. We are particularly interested in the effects arising from aero-structure-control interactions.

Research topics of interest include energy dissipation mechanisms, dynamic instability, system identification, and aeroelasticity. We also support development of new structural control approaches for suppressing vibrations, modeling of the time-varying structural configurations, and investigating the robustness of multibody systems. We seek the capability to model accurately structural-thermal interactions, including the structural response to intense thermal radiation and thermal diffusion through multilayered, actively cooled structures exposed to aerothermodynamic heating and surface reactions in hypersonic flight.

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Mechanics of Materials

Research in this program seeks to establish the fundamental understanding required for predicting the mechanical performance of aerospace structural materials when subjected to thermomechanical and environmental loading that simulates expected service conditions.

Projected Air Force applications will require multifunctional structures capable of sustained performance in extreme loading environments. Candidate structural material systems are almost all multiphase, highly heterogeneous media. These systems include metallic and intermetallic alloys, advanced composite material systems (including polymer-matrix, metal-matrix, ceramic-matrix, and carbon-carbon composites), and solid rocket propellants and liners.

The continuing drive for safer, more durable aerospace vehicles with improved performance characteristics depends on researchers' ability to understand, characterize, and quantitatively model the expected behavior of such emerging material systems. Therefore, particular emphasis is placed on developing the mechanics principles and methodology appropriate for treating multiphase materials. Specifically, quantitative connections between evolving microstructural features and resulting performance parameters must be established. An analytical understanding of the relationship between processing and microstructure is also sought. Interdisciplinary approaches that include mechanics, materials science, chemistry, physics, and applied mathematics are encouraged, as are combined analytical/experimental efforts. Interaction with Air Force laboratory researchers who are conducting basic research, as well as those in exploratory and advanced development programs, is also encouraged.

Researchers in this program are aggressively pursuing constitutive models incorporating damage mechanism parameters as dependent variables, nonlinear fracture and damage mechanics, and physically founded stochastic approaches. Particular emphasis is placed on material systems that are capable of operation in extreme temperature environments, such as those to be utilized in future engine and airframe component designs. It is essential to develop innovative experimental methods for observing the response of materials to service-like loading in real time and in appropriate environments, and to use these methods for in-situ measurement of constituent properties and for damage evolution monitoring.

Researchers in this program also seek to understand and describe the structure and function of naturally evolved materials as a first step toward producing aerospace materials and structures with superior properties by imitating, to the extent possible, the processing and design principles found in nature.

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Particulate Mechanics

Particulate mechanics research aims to develop a more fundamental understanding of the behavior of particulate materials with an emphasis on geologically derived materials such as soil, rock, and concrete. The ultimate goal is to predict more accurately the behavior of aerospace support facilities composed of these materials when subjected to blast and impact loading. The response of geologically derived materials often controls the design of airfield pavements, aircraft shelters, munitions bunkers, missile silos, and deep underground facilities used for command and control. Knowledge of both the

vulnerability of targeted structures and the survivability of our own facilities requires a thorough understanding of the materials that support, protect, or surround these structures.

Proposals for basic studies in particulate mechanics should emphasize the material response and characterization at both the microscopic and macroscopic levels. We seek to obtain quantitative theories to explain the deformation and failure of the particulate material systems. Many current design and analysis methods are based on empirical relationships and fail to address the fundamental behavior of these heterogeneous, anisotropic, multiphased, particulate material systems.

Our current research interests include (1) the influence of microstructure on overall constitutive behavior, (2) the constitutive behavior of multiphase particulate materials, and (3) localization and instability in particulate media, including their potential to flow and to liquefy.

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Structural Mechanics

The objective of this research program is to provide the fundamental knowledge required to understand system behavior and ensure integrity of aerospace structures, including aircraft, missiles, and spacecraft. The program also supports computational and experimental research efforts leading to the development of improved systems and materials for the optimal performance of future aerospace structures.

We seek proposals for developing fundamental solid mechanics to better understand structural nonlinear characteristics and material inelastic behavior. We are particularly interested in the correlation of local and global responses of structural systems, the deformation and fracture mechanisms in materials, and the measurement of their microstructural changes.

Current topics of interest include nonlinear structural behavior, material instabilities, and scaling the role of inhomogeneities on structural response and homogenization. We also seek improved numerical methods that will lead to a realistic simulation of failure phenomena.

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External Aerodynamics and Hypersonics

This research program seeks to improve the understanding of fluid flow phenomena that strongly influence the aerodynamic performance and efficiency of flight vehicles relevant to the Air Force's mission requirements. This program comprises three technical thrust areas: compressible turbulence, advanced computational fluid dynamics (CFD) research, and hypersonics. Research should focus on the physical mechanisms that govern these classes of complex flows.

The study of compressible turbulence comprises experimental, analytical, and computational research whose aim is to reveal the fundamental structure and properties of high speed, compressible turbulence. Research is needed to determine the fundamental nature of compressible turbulence structure in complex shock wave interaction flows with turbulent boundary layers. These flows routinely occur in engine inlets of supersonic and hypersonic flight vehicles and over advanced aircraft wings and missile shapes.

In advanced CFD research, unstructured grid methods are being developed. Research is ongoing to develop methods capable of simulating complex, three-dimensional, time-dependent flows created by aircraft platforms during dynamic maneuvers. These full Navier-Stokes simulations are three-dimensional, time-dependent, and include viscous effects which range from laminar, through transitional, to fully turbulent boundary layer states. We are also interested in developing analysis capabilities for hypersonic engine inlet unstart processes.

Research in hypersonics should improve the understanding of complex, time-dependent, three-dimensional viscous flows with and without real gas effects and advance the accuracy of numerical simulation methods. We are especially interested in three-dimensional Burnett equation numerical methods and direct numerical simulation methods with rate chemistry. We are also interested in wind tunnel research that investigates the fundamental fluid mechanics of high Reynolds number as well as high-enthalpy hypersonic flows.

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Internal Fluid Dynamics

Research in this area is motivated by problems relevant to the air-breathing propulsion requirements of the Air Force. This research focuses on understanding and controlling complex internal flows, as in axial flow compressors and axial flow turbines. Emphasis is on understanding the role of unsteadiness and three-dimensionality in design, performance, stability, and heat transfer to obtain more efficient and lightweight high-performance engines. We are exploring active control strategies for rotating stall and surge instability in gas turbine engine compressors as well as examining the influence of inlet distortion and compressibility effects. We are also developing improved understanding and predictive techniques for unsteady heat transfer in gas turbines.

The principal areas of concentration include high free stream turbulence, stagnation point heating and wing/body juncture flows, and transition heat transfer phenomena. An important goal is to integrate fluid dynamics with heat transfer to aid in determining and modeling the key mechanisms responsible for high heat transfer rates in these severe environments. Recently, we have begun to address high-speed, high-flow turning phenomena in direct support of low-aspect-ratio, high-work compressors and turbines.

We are interested in innovative research that illuminates the physical mechanisms governing internal flows. We encourage an interdisciplinary approach to understanding and solving the problems associated with rotating stall and surge, incorporating bifurcation analysis and nonlinear control theory, to improve the modeling of compressor instabilities.

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Turbulence Prediction and Control

This research program seeks fundamental understanding of physical mechanisms governing the onset and evolution of turbulence in bounded and free shear flows. It also seeks application of that understanding to develop advanced models and concepts for predicting and controlling turbulent and transitional flows.

The research emphasizes mechanisms responsible for the origin and regeneration of large-scale, coherent structures as well as the dynamics of fine-scale turbulence. In this context, we are interested in theoretical approaches to understanding both natural and driven flow instabilities. We encourage research on the influence of background and imposed disturbances, pressure gradients, flow curvature, and compressibility on these mechanisms. We are also interested in research directed toward understanding the connection between chaotic advection and mixing in three-dimensional flows.

Direct numerical simulations of the temporal and spatial evolution of transitional and turbulent flows may provide insights into governing physical mechanisms, guide the formulation of new predictive models, and suggest innovative concepts for controlling aerodynamic lift and drag as well as turbulent mixing and transport. Also of interest are ideas to advance principles and methods for large-eddy simulation, especially subgrid modeling, and ideas on the behavior of turbulence at high Reynolds numbers. We seek original ideas and concepts leading to new or significantly improved approaches to turbulence modeling, especially ideas on incorporating the physics of turbulent structures into predictive turbulence models. We are interested in research that targets new concepts and approaches for interpreting very large arrays of time and space-resolved data in terms of underlying physical processes. We seek new ideas for significantly advancing our experimental diagnostic capability, providing time- and space-resolved data on fundamental flow structures and their interactions. Innovative ideas on the use of helium as a working fluid for turbulence research at moderately high Reynolds numbers, incorporating integrated microdiagnostic techniques, are also of interest. Research on the development of microsensors, microdiagnostics, and integrated arrays of micro-actuators is of interest in the context of flow control and turbulence diagnostics.

We are interested in collaborative, interdisciplinary research involving fluid dynamics and control theory that may lead to new approaches for controlling transition and turbulence. Of particular interest is the application of concepts from distributed-parameter control theory to develop new algorithms for flow control. Research on new sensor and actuator concepts for flow control, including the application of microelectro-mechanical systems, is encouraged. Ideas on the dynamics and control of longitudinal vortex flows are of particular interest.

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Unsteady and Separated Flows

This research program focuses on understanding and controlling unsteady separation and vortex development over lifting bodies in unsteady, high-angle-of-attack maneuvers. The emphasis is placed on three-dimensional lifting surfaces undergoing prescribed motion, although select quasi-two-dimensional lifting surfaces will be investigated to continue pursuit of a theoretical framework for unsteady separation and to elucidate the physics of compressibility effects on dynamic separation events. We emphasize enhancing aerodynamic performance, especially aircraft agility, through the understanding and control of energetic unsteady flow fields.

Principal areas of concentration include flow separation, leading-edge vortex development, and vortex breakdown from swept leading edges; evolution from flow separation to fully stalled flow on swept wings, including interactions between opposite leading-edge vortices; identification of major elements of unsteady flow structure that determine unsteady loading and associated phase shift and dynamic hysteresis; and the use of the vorticity balance concept to relate flow structure to loading. The control of unsteady forebody flows, either by fluid-induced or structural perturbations, is also being investigated. This research directly contributes to improving nonlinear aerodynamic models that must account for history effects, hysteresis, and aerodynamic bifurcations to maintain sound flying characteristics well into the

post-stall regime. Recently, a new thrust was established to address the flow physics and fluid-structure interactions associated with the impingement of three-dimensional unsteady vortical flows upon wing and tail components. We seek innovative proposals for basic experimental and computational investigations that will extend our understanding of the physical processes involved.

We encourage collaborative, interdisciplinary approaches involving fluid dynamics and control theory and fluid-structure interactions—approaches that will provide new ways of predicting, sensing, controlling, and interacting with unsteady flows. Basic interdisciplinary research combining unsteady aerodynamics and flight mechanics also is needed to understand and predict the behavior of vehicles and missiles performing unconventional dynamic maneuvers.

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Airbreathing Combustion

Fundamental understanding of the physics and chemistry of multiphase, turbulent reacting flows is essential to improve the performance of air-breathing propulsion systems.

We are interested in innovative research proposals that use simplified configurations for experimental and theoretical investigations.

Our highest priorities are studies of supersonic combustion, atomization and spray behavior of slurries and liquids, fuel combustion chemistry, and supercritical precombustion fuel behavior. Other topics of interest include turbulent combustion, soot formation, and interactive control.

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Space Power

Wide-area surveillance and space-based defense require affordable on-demand/on-schedule launch and orbit transfer vehicles and accurate plume prediction models.

Research activities fall into two areas: nonchemical orbit-raising propulsion and chemical propulsion. Research in the former area is directed primarily at advanced space propulsion and is stimulated by the need to transfer very large payloads between orbits. It includes studies of the sources of physical (nonchemical) energy and the mechanisms of release. Our emphasis is on understanding electrically conductive flowing gases (plasmas) that serve to convert beamed or electrical energy into kinetic form. Theoretical and experimental investigations are being conducted on the phenomena of energy coupling and the transfer of plasma flows in electrode and electrodeless systems under plasmadynamic environments.

Topics of interest include characteristics of pulsed and steady-state plasmas; characteristics of equilibrium and nonequilibrium flowing plasma; characteristics of electrical and hydrodynamic flows; instabilities of plasma bulk and wall layers; interactions of plasma-surface, -electrode, -magnetic, and -electric fields; losses to inert parts; characteristics of plasmas in high-magnetic fields and pressures; ionized cluster beam formation for ion thrusters; and plasma diagnostics (new and unique noninterfering measuring techniques).

Research is being conducted on chemical propulsion to predict and suppress combustion instability in solid and liquid rocket systems, to control the complex role of advanced energetic ingredients in solid propellant burning, to permit the use of metal fuels, including condensation and oxidation dynamics of metal atom doped clusters, and to improve the service life of solid motors, including propellant aging and toxicity.

We are interested in new diagnostic techniques for analyzing surface reactions and flames of propellants and for controlling the state of combustion products in plumes.

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Aeropropulsion Diagnostics

Research is directed at new techniques for sensing temperatures, concentrations of chemical constituents, and velocities in energy conversion systems without interfering with the operation of the systems. The research emphasizes diagnostics of laboratory systems that simulate the hostile environments of high-performance combustion and plasma systems and sensors for onboard control of propulsion systems.

Of interest are combustion and plasma flows, including multiphase reactions, gas-solid interactions, sprays, and reactions under supersonic conditions. We are exploring sensing and diagnostic techniques and strategies consistent with advances that are expected in adaptive controls. Topics include the quantitative imaging of plasma flows, monitoring rapid surface reactions, using nonoptical sensors, instantaneously mapping velocities, and formalisms for exploiting array data. We seek proposals that introduce techniques rather than apply advanced diagnostics as part of the research.

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CHEMISTRY AND MATERIALS SCIENCES

Chemical Reactivity and Synthesis, Dr. Hedberg
Polymer Chemistry, Dr. Lee
Inorganic Materials Chemistry, Capt. Erstfeld
Electrochemistry, Dr. Wilkes
Theoretical Chemistry, Lt. Col. Burggraf
Molecular Dynamics, Dr. Berman
Metallic Structural Materials, Dr. Rosenstein
Ceramics and Nonmetallic Structural Materials,
Lt. Col. Burggraf

Research in chemistry and materials sciences addresses five basic issues: processing chemistry, energy interconversion phenomena, characterization of the aerospace environment, metallurgy, and ceramics. More details of our special interests are outlined in this section. Besides our contract and grant program, we include in our overall program inhouse research at two Air Force laboratories: the Wright Laboratory (materials, aeropropulsion and power, and armament) and the Phillips Laboratory (geophysics, rocket propulsion, lasers and imaging, and advanced weapons and survivability).

Chemical Reactivity and Synthesis

Through this research we seek new and better methods of preparing and characterizing new organic, inorganic, and organometallic compounds and formulations. We explore associated reaction kinetics, reaction mechanisms, and molecular structure/property relationships, utilizing both theoretical and empirical methods.

Current objectives include novel approaches to the molecular design, synthesis, and reaction mechanisms of chemical intermediates that can be used as monomers for organic polymers that will extend current long-term thermooxidative usage limitations, or as volatile precursors for deposition of electronic, electrooptical or oxidation-barrier coating materials. We are also interested in the design, synthesis, and characterization of novel lubricant molecules that can extend current long-term thermooxidative usage limitations; organic polymers that may provide the optimal combination of physical, mechanical, and electronic properties for advanced electronic packaging applications; and energetic compounds that could be used as high-energy ingredients in propellants and explosives. We seek an understanding of the chemical behavior of aircraft turbine engine fuels under supercritical conditions with a goal of inhibiting degradation. In the biotechnology area, we are pursuing applications of bacteria and enzymes both to the synthesis of key aerospace chemical intermediates and to the degradation of environmentally hazardous aerospace materials. We are seeking to understand and mimic design and crystal growth processes found in naturally occurring systems in order to obtain improved structural and electrooptical materials. In the environmental area, we are investigating the chemical and biochemical fate of hazardous aerospace materials that may be released into the environment. We are interested in molecular modeling studies utilizing theoretical, semiempirical, or intelligent database development approaches to obtain predictive methods of correlating molecular composition with engineering properties, as well as validation of these studies through synthesis and characterization.

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Polymer Chemistry

The goal of this research area is to gain a better understanding of the relationship between chemical structures and processing conditions and properties of polymeric and organic materials. The purpose is to identify chemical structures, processing conditions, and applications of these materials to satisfy the current and future requirements of Air Force advanced systems. The approaches to meeting this goal include (1) synthesizing new chemical structures for properties enhancement and processing modification, (2) investigating the physical behaviors and chemical phenomena of polymers and organic materials to comprehend their properties and processing characteristics, and (3) studying the chemical aspects of the processing science of these materials.

A major objective of the current program is to develop fast-response nonlinear optical (NLO) and electrooptical polymers and polymeric systems for photonic, electrooptical, and optoelectronic applications. A current emphasis is to identify physical and electronic mechanisms and chemical structures that can improve the second- and third-order macroscopic nonlinearity of polymeric materials beyond the state of the art. Improvements in processibility and temporal stability of these materials, especially for the second-order nonlinear materials, are highly desirable.

A new concept being pursued is multifunctional polymers and polymeric systems. This concept is being broadened to include ceramers, an alloy of ceramics and polymers. Many advanced devices and systems require a combination of different functionalities to operate properly. The most common approach is to fabricate a system that is a composite of different materials. Combining these properties in a single material will eliminate many material compatibility problems and provide an enabling material technology for many emerging applications, such as smart materials that can change their properties by responding to their environments in predetermined ways.

Materials based on this concept will make it possible to combine different devices into one system. An example is head-up display materials. By making the display materials transparent, devices that are normally placed on the instrument panel can be built into the canopy.

Another goal of this concept is the creation of new properties through combinations of properties, such as the creation of photorefractivity through the combination of photoconductivity and electrooptic properties. An additional goal is to provide materials that possess coupled properties, so that the change of one property, either in a controlled fashion or otherwise, can change the other properties. These materials can be very useful for sensors and function controls.

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Inorganic Materials Chemistry

The inorganic materials chemistry program supports basic research for synthesis, processing, and characterization of structural materials and thin films. The ultimate goal of this program is atomic-scale control in the processing of materials.

Structural materials research deals with the chemistry of solution ceramics, glasses, semiconductors, and oxidation-resistant carbon/carbon composites. The focus of this research is to produce structural, optical, electronic, and electrooptic materials that perform better and at lower cost than current materials. These materials are to be used in systems for space and aerospace environments.

Thin film research deals with control of chemical reactions at surfaces and interfaces. This research includes (1) the processing and characterization of electronic and electrooptic materials that are essential to future information systems and command, control, and communications systems; (2) the chemical control of degradation (corrosion) of materials, which includes friction at surfaces, to understand the role of lubricants essential to future aerospace systems operating at high temperatures, and hyperthermal surface reactions in the space environment to design inert skins for space vehicles; and (3) the chemistry of catalysts for endothermic fuels to determine selectivity and efficiency to design a catalyst/supercritical fuel system for the high-temperature engines proposed for 21st-century aircraft.

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Electrochemistry

Electrochemistry research is directed at fundamental aspects of electrochemical power generation and storage. Our program provides the technology for such devices as batteries, fuel cells, and photoelectrochemical cells.

Our focus is on materials used in electrochemical cells and processes occurring at the electrode-electrolyte interface. The electrochemical materials include nontraditional electrolytes such as molten salts, polymers, and solid-ion conductors. We are primarily interested in new materials that may improve battery performance and reliability. We seek to expand the fundamental understanding of electrode processes through the development of ex-situ and in-situ surface analysis, electrocatalysis, and electrode activation.

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Theoretical Chemistry

Theoretical chemistry research focuses on new tools and methodologies to permit accurate and timely calculations of molecular properties of interest to chemists. Materials systems of primary interest are lightweight materials and electrooptic materials important to advanced aerospace technology. Areas in which prediction of materials properties by computational chemistry plays a vital role include high-energy-density materials, nonlinear optical (NLO) polymers, and tribology.

The primary goal is to develop theoretical tools and methodologies to apply to molecular and condensed phase systems of interest to the Air Force. In particular, methods are needed to allow accurate and rapid calculation of molecular geometries, energies, lifetimes of excited states, rates of intermolecular energy flow, and kinetic parameters for elementary steps in chemical reaction mechanisms. Accomplishment of these objectives will further develop theoretical chemistry as a useful partner to experimental chemistry for understanding chemical phenomena.

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Molecular Dynamics

The objectives of the molecular dynamics program are to understand, predict, and control the reactivity and flow of energy in molecules. Research focuses on dynamics of molecular interactions, fundamentals of chemical reactivity, storage of energy in molecules, and energy transfer in molecules. Studies typically examine well-defined microscopic molecular systems undergoing reactive and nonreactive molecular collisions. Detailed spectroscopic studies are also encouraged.

Areas of emphasis include reactions of atmospheric species that produce radiant emissions; dynamics of ion-molecule reactions; energy transfer; gas-surface interactions; energy storage in metastable or energetic molecules for use as propellants; new chemical laser concepts; and the fundamental understanding and control of chemical reactivity and bonding.

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Metallic Structural Materials

Research addresses advanced metals, alloys, intermetallics, and metal matrix composites for engine, airframe, and spacecraft structural (load-bearing) applications.

The goal of this research is to provide the fundamental knowledge required to create, synthesize, process, design, and improve metals and alloys used in aerospace applications. Specific topics are metallurgy of structural materials, hybrid materials, computational materials science, fatigue and fracture, interface phenomena, processing science, high-temperature materials, intermetallic alloys, and metal matrix composites. Investigations are aimed at understanding the behavior of materials at ambient and elevated temperatures. Such behavior includes strengthening mechanisms, phase transformations, plasticity, creep, fatigue, environmental effects, dynamic and static fracture, and the experimental verification of theoretical and computational (atomistic) models.

Understanding the relationships between alloy chemistry, nano-micro-macrostructure, materials processing, and mechanical behavior is an essential aspect of this program. The scientific issues that drive this research include synthesis of non-equilibrium materials, nanoscale microstructures, interface phenomena, deformation processes, fatigue and fracture mechanisms, computational materials science as applied to alloy theory and alloy design, and experimental verification of theoretical predictions. The relationship of atomic phenomena to bulk mechanical properties is a major focus of this research. The metallurgical systems of major interest are the intermetallics, niobium alloys, and metal matrix composites in general. The utilization of computer simulation, high resolution electron microscopy, transmission electron microscopy, scanning electron microscopy, sophisticated processing, and other advanced laboratory techniques will add to the success of this research program. This year, specific emphasis will be on high-temperature materials. In addition, a FY 93 initiative is planned on nanocrystalline metallic structural materials, including processing, characterization, mechanical property mechanisms, and property stabilization in these materials.

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Ceramics and Nonmetallic Structural Materials

The potential benefits of using ceramics, ceramic composites, and nonmetallic materials in aerospace propulsion, space structures, and electrooptics are enormous and pervasive. Performance advantages, including high-strength and high-temperature capability, of nonmetallic oxides, silicides, borides, nitrides, carbides, and carbon/carbon composites are accelerating their applications in aerospace propulsion. Nonmetallic materials that operate at the highest use temperatures are replacing metals in temperature-critical applications such as bearings, turbines, and nozzle structures for high-performance turbine engines. For hypersonic aircraft and space structures lightweight, high-temperature carbon/carbon materials are required for structural elements. Two general limitations restrict wider applications for ceramics and nonmetallic materials. The first is the need for reproducible, efficient, economical processing to achieve the desired properties of strength, toughness, and oxidation resistance. The second is the need for predictable performance lifetimes for these materials.

This research program focuses on a fundamental understanding of the physical, chemical, and mechanical properties of nonmetallic materials. Microscopic architectures produce the macroscopic properties of interest, such as toughness, strength, oxidation resistance, and tailored electrooptical properties. Of critical importance is the understanding of fundamental issues that link the processing-microstructure-properties chain. Processing techniques to produce composite microstructures and interface with nanostructures having advantageous atomic-level distribution of dopants in polycrystalline or heterogeneous materials must be understood. Particularly important are novel precursors and processing for yttrium aluminum garnet (YAG) fibers, oxide matrices, and carbon matrices. A better understanding of the relationships between the electronic structure and physical properties of ceramics will enable us to tailor properties of ceramic materials. Complementary research to model failure mechanisms is important to correlate structure with materials performance and lifetime.

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PHYSICS AND ELECTRONICS

Joint Services Electronics Program, Maj. Smith
Electronic Devices, Components, and Circuits, Dr. Witt
Photonic Devices and Systems, Dr. Craig
Quantum Electronic Solids, Dr. Weinstock
Semiconductor and Electromagnetic Materials, Lt. Col. Pomrenke
Photonic Physics, Dr. Schlossberg
Optics, Dr. Schlossberg
X-Ray Physics, Dr. Schlossberg
Atomic and Molecular Physics, Dr. Kelley
Plasma Physics, Dr. Barker

Research in physics and electronics provides the fundamental knowledge needed to advance Air Force operational capabilities in surveillance; guidance and control; information and signal processing; and communications, command, and control. The program is of substantial scientific breadth, extending from elementary and quantum physics, to understanding the performance of novel electronic devices, and to engineering issues such as systems performance and electronic and photonic materials processing techniques. The program is carried out in collaboration with selected Air Force laboratories such as the Rome Laboratory, the Wright Laboratory, and the Phillips Laboratory.

Joint Services Electronics Program

The Joint Services Electronics Program (JSEP) is a mutual enterprise of the Army, Navy, and the Air Force designed to provide the Department of Defense with a university-based research capability in the electronics sciences and related areas. Each of the 12 major universities currently involved in the program carries on a multidisciplinary research program in one or more of the following subjects: solid-state electronic materials and devices, electromagnetics, quantum electronics, and information electronics. The tri-service management team strives to maintain relevance of the research subjects and a balance among the major themes.

Proposals should address the problems to be investigated, approaches to be used, expected results, relationship of the proposed research to other active work at the university, qualifications of the principal investigators, and cost of the proposed research.

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Electronic Devices, Components, and Circuits

The research program encompasses a wide variety of advanced electronic structures and devices, primarily fabricated from compound semiconducting materials. A range of materials systems (e.g., gallium arsenide, indium phosphide, silicon-germanium alloys on silicon, the antimonides, heteroepitaxial materials) and devices (such as pseudomorphic high electron mobility field effect transistors, heterojunction bipolar transistors, resonant tunneling structures) are of interest—especially those structures exploiting quantum mechanical effects. The use of Si-Ge alloys for device applications is of particular interest. Special focus is placed on the understanding and applications of so-called "low-temperature" GaAs and related layers. We seek research proposals in approaches to wafer-level integration such as selected area heteroepitaxy, the use of patterned substrates, and the lift-off layer technique.

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Photonic Devices and Systems

This program comprises two aspects: the development of optical materials and devices, and the study of the organization of these components for insertion into optical and optoelectronic computational and information processing systems. Emphasis is on coordinating device exploration and architectural developments; synergistic interaction of these areas is expected, both in structuring architectural directions according to device capabilities needs and in focusing device investigations according to system needs.

Research in optical materials and devices focuses on insertion of optical technology into computing systems. This program continues to foster surface-normal interconnect capabilities, combining detector arrays with spatial light modulators or arrays of optical modulators (or sources) at local processing elements. Particular emphasis is on initiatives such as exploring optical memory capabilities demonstrated by persistent spectral hole-burning techniques or by photorefractive materials in page-oriented or holographic configurations and investigating spectral diversity in processing, pursued via devices enabling transmission, emission, filtering, and switching. The devices considered will be high speed, low energy, and robust and will incorporate gain, logic, or memory capabilities, with prospects for array configurations. Understanding the fundamental limits of the interaction of light with matter is crucial. Semiconductor technology incorporating engineered materials will be used whenever possible and appropriate. This approach will lead to "building block" components that can be used in diverse optical implementations.

System-level and architectural investigations incorporate these devices into computing architectures, taking advantage of their demonstrated and envisioned future attributes and determining the appropriate choice of problem class for optical or optoelectronic approaches. The computational advantages and the proper use of parallelism provided by optical implementations continue to guide architecture and device development. In addition, a new emphasis is evolving, stressing the use of the inherent extremely wide bandwidth of optical carriers. Computer processing components continue to encounter increasing difficulty in signal transmission, constrained by wire-crossing restrictions, electromagnetic interference, and crosstalk, an impediment that may be ameliorated by optical interconnect approaches. Serial access to memory slows processing, causing what has come to be known as

the Von Neumann bottleneck; parallel access capability promised by optical approaches may alleviate this constriction. Concepts to incorporate the extremely wide bandwidth capacity of the optical carrier may enhance the capability of future switching and processing computational machines. System-oriented efforts comprise matching computing paradigms via architectures to these optical capabilities. Current architectural issues being investigated include the contribution of optical interconnects to communication between electronic processors and the organization of optical and optoelectronic devices into processing elements to perform digital computation functions; the role of optics in memory devices for resolving capacity, latency, and access limitations; the possibility of processing in the spectral domain for performing data packet routing, byte-parallel transmission, and functions of medium-scale integration complexity; and the apparent special, though restricted, conformation of optical technologies to neural networks based on the capacity for random, space-variant interconnects with fan-in and fan-out capability. This research pursues the development of intensively parallel, adaptive, or fault-tolerant computing systems that will be used to alleviate Air Force problems in areas such as smart munitions, electronic warfare, and artificial intelligence.

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Quantum Electronic Solids

The components of this program involve materials that exhibit cooperative quantum electronic behavior, such as ferromagnets or superconductors, with the primary emphasis on the latter, and any conducting materials whose surfaces can be modified and observed through the use of scanning tunneling and related atomic-force microscopies. The program also deals with device concepts utilizing these materials for electromagnetic detection and signal processing in Air Force systems.

The materials aspects of the program are based on the fabrication, characterization, and electronic behavior of thin films, which can ultimately lead to the discovery of new and improved electronic circuit elements. The major thrust is in the area of superconductivity, with a strong effort already in progress to understand the mechanisms that give rise to this phenomenon in selected ceramics and to produce high quality Josephson tunneling structures. Currently there is considerable interest in finding superconducting behavior in other families of materials, with the hope of discovering such behavior at ever-higher temperatures. Magnetic thin-film interest, while limited, is focused on structures that may ultimately prove useful for incorporation into microwave circuit elements.

An evolving interest in this program is the search for new device concepts that involve superconductive elements, either in total or in concert with semiconductors and normal metals. Such concepts may involve any type of superconductor, metallic low-temperature superconductors or ceramic high-temperature superconductors. Examples of interest include flux-flow transistors, phase-locked Josephson-junction arrays, squeezed-state heterodyne mixing, and any unique geometry that utilizes the electronic properties of the superconductive state.

A newer aspect of this program is the inclusion of scanning probe techniques to fabricate, characterize, and manipulate atomic, molecular, and nanometer-scale structures on substrates of technological interest. These techniques, such as scanning tunneling microscopy and scanning electrochemical microscopy, can be used to create new molecular entities that are expected to permit reliable control of the motion of a single electron, and, in turn, to lead to a new generation of supersensitive electrometers and infrared detectors, and to the ultimate miniaturization of analog and digital circuitry.

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Semiconductor and Electromagnetic Materials

Air Force electronic and photonic signal processing, communications, surveillance, and electronic warfare systems require continual improvements in performance. This research program is directed toward developing advanced electronic and photonic materials to provide the required improvements in future Air Force electronic and photonic systems. In particular, we seek to generate the fundamental knowledge and the materials database required for the growth and use of novel, as well as existing, electronic and photonic materials and structures. No single electronic material has the combination of properties required for all applications, so several classes of semiconductor materials, including a variety of heterostructural combinations, are currently under investigation. Similarly, several classes of photonic materials, including semiconductor heterostructures and nonlinear optical and magnetooptical materials, are also under investigation.

Compound semiconductors such as gallium arsenide and indium phosphide, the ternary alloy gallium aluminum arsenide, and heterostructural combinations of such materials are the foundation of a whole new generation of ultra-high-speed, high-frequency digital and microwave devices. These materials provide the electronic and optoelectronic properties necessary for advanced information and signal processing applications

and for optoelectronic communications. We are investigating these materials for potential use in detectors for the ultraviolet to far-infrared region, solid-state lasers, display and emitter sources, and in infrared-active optoelectronic countermeasures. More recently, material issues are being pursued in the II-VI nitride and III-V antimonide compound semiconductors.

An effort to develop a Group IV semiconductor, specifically, silicon-germanium heterostructure technology for next-generation digital computer, microwave, and optical sensor systems, has begun and will continue. Efforts continue to develop combinations of Group II-VI and III-V materials and Group IV and Group III-V materials heterostructure technology for future device applications. Novel concepts are being explored in quantum transport and structures. Interface issues and understanding of equilibrium and non-equilibrium growth processes through modeling are also important in heterostructure technology. Interest exists in developing a high level of material integration using selective-area epitaxy and growth on patterned or nonplanar substrates. Our overall emphasis is to combine materials science with solid-state physics to investigate the fundamental aspects of growth, defects, and properties of multilayer semiconductor structures. Numerous opportunities remain to be explored in the area of heteroepitaxy of dissimilar materials and the bulk growth of nonlinear-optical and semiconductor materials that will continue to have a substantial impact on electronics and electrooptics.

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Photonic Physics

Research in this subarea seeks new ideas, knowledge, and insights in broad aspects of photonics. Ultrafast optoelectronic techniques are being intensively investigated to dramatically advance the speeds and available power of electronic circuits. Picosecond and femtosecond optical pulses are being investigated to generate very wide band signals and to control and test electronic circuits at frequencies into the millimeter wave range and far beyond, into the terrahertz range. Optical interconnect techniques are being investigated for application, especially to millimeter wave circuit interconnections. Optoelectronic generation of very high power terrahertz pulses are being studied, which could significantly contribute to so-called impulse radar systems. Very wide band, mode-locked semiconductor lasers are being devised and investigated as important devices in their own right, as well as for practical implementations of ultra-high-speed electronic studies. Semiconductor laser arrays are being intensively investigated as research support to ongoing Air Force development programs. Very-low-noise and very-low-threshold semiconductor lasers are being pursued for applications in communications and information processing. Directed energy beams, particularly laser beams, are being explored in a wide variety of direct-write materials processing techniques, which offer broad and extremely important new capabilities, particularly in microelectronics fabrication and packaging.

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Optics

This subarea supports research in optically pumped solid-state lasers, nonlinear optics and adaptive optics, and a variety of novel optical techniques. Nonlinear optical techniques, particularly two-wave and four-wave mixing techniques in photorefractive materials and four-wave mixing in Kerr media, are being investigated for a variety of novel, potentially important applications, such as optical beam combining and quality enhancement, image amplification, and novelty filtering. Novel nonlinear optical materials are being investigated, including the cladding of single crystal optical fibers and the use of resonances in gases. The latter are made very attractive by recent capabilites to produce semiconductor diode lasers that are accurately tuned to the resonances. Gases embedded in "caged" solids are being studied. These materials could offer the benefits of resonances in gases at high pressure, but in solid-state form. New, higher power, higher efficiency, compact, frequency-selectable or tunable lasers are being studied, especially semiconductor-pumped solid-state lasers. Novel, efficient means are being devised to convert the wavelength of existing lasers into new regimes important for applications. Nonlinear optical techniques are being extended to the millimeter wave region, principally through the study of nonlinear transmission lines. New techniques are being developed in near field optical microscopy, a field with revolutionary technological possibilities.

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X-Ray Physics

New concepts, with potentially revolutionary scientific and technological payoff, are being studied in the generation, control, and application of soft and hard x-rays. Generation studies include those aimed at x-ray lasers and laser plasma generated x-rays, particularly by femtosecond pulse lasers. Imaging techniques are being investigated in the soft x-ray range for application to analysis and diagnostics of physical, electronic, and

biomedical nanostructure systems. A multifaceted materials and analysis program in multilayer x-ray mirrors is progressing to elucidate the physics and how to control the interface roughness and material intermixing at layer boundaries. Major thrusts are to extend high reflectivities to shorter wavelengths and to coat curved (focusing) optics at high reflectivity. Application studies include x-ray microscopy and microanalysis. Studies are being undertaken for the understanding and development of a science and technology of nonlinear optics in the x-ray region. Theoretical and experimental studies are being supported with the general vision of building, over time, an x-ray technology as facile as today's optics technology.

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Atomic and Molecular Physics

This program involves experimental and theoretical research on the properties and interactions of atoms and molecules and forms the basis for a large range of technological applications in navigation, guidance, communications, low- and high-altitude nuclear weapons effects phenomenology, directed energy weaponry, frequency control devices, and lasing mechanisms.

Among the topics of interests are the following:

1. Trapping and cooling of atoms and ions for high-resolution spectroscopy, establishment of frequency standards, and study of cold atom collisions. Frequency multiplication/division between optical and microwave regions.

2. Electronic, vibrational, and rotational energy levels, transitions, selection rules, spectra, and oscillator strengths. Molecular structures and symmetries.

3. Theories and efficient methods of calculating atomic and molecular properties, orbitals, and wave functions (with emphasis on inclusion of electron correlation effects).

4. Ultraviolet emission cross-sections of atmospheric species.

5. Interactions of atoms in strong electric, magnetic, and radiation fields.

The advanced energy work promotes physics of advanced energy sources and efficient energy conversion technology. The principal interest here is the study of antimatter. Problem areas include understanding basic properties, cooling antiprotons, storing condensed antimatter, controlled containment and conversion of annihilation energy, and more efficient production of antimatter.

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Plasma Physics

We are seeking innovative concepts that promise increased understanding of the collective behavior of particles (ions and electrons) and their self-consistent production of, and interaction with, electromagnetic fields.

Topics of particular interest include electron-beam-driven millimeter and submillimeter radiation sources, computer simulation of plasma phenomena, intense charged-particle-beam accelerators, microwave absorption and scattering by plasmas, and the production of high-power (gigawatt-level) microwaves in the frequency range of 0.1 to 100 GHz.

Proposals should indicate how the research might influence Air Force applications in 10 to 20 years. Complete, multiyear (2 to 4 years) research programs can be considered. These investigations may be computational, experimental, theoretical, or some combination of the three.

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LIFE AND ENVIRONMENTAL SCIENCES

Neuroscience, Dr. Haddad
Chronobiology, Dr. Haddad
Perception and Recognition, Dr. Tangney
Spatial Orientation, Lt. Col. Collins
Cognition, Dr. Tangney
Bioenvironmental Sciences, Dr. Kozumbo
Terrestrial Sciences, Dr. Dickinson
Meteorology, Lt. Col. Stobie
Ionospheric Science, Lt. Col. Stobie
Optical and Infrared Environment, Lt. Col. Stobie
Space Sciences, Dr. Radoski

The Directorate of Life and Environmental Sciences supports basic research in a number of areas of high interest to the Air Force. In addition to extramural grants, complimentary basic research programs related to these areas are supported in Air Force laboratories. The Armstrong Laboratory, headquartered at Brooks Air Force Base in San Antonio, Texas, is the primary laboratory for life sciences-related research. The primary laboratory for terrestrial, atmospheric, and space sciences research is the Geophysics Directorate of the Phillips Laboratory located at Hanscom Air Force Base, Massachusetts. Many opportunities exist for collaborative research between academic scientists and Air Force laboratory scientists. Further information on these opportunities can be obtained from the program managers listed in this section.

Neuroscience

This program supports basic research on the neurobiology of behavior. The ultimate objective is to understand the neural mechanisms that determine the effectiveness of skilled, healthy persons performing demanding mental and physical tasks. Areas of emphasis are fundamental studies of the neurobiological mechanisms underlying neuronal responsiveness, learning and memory, fatigue, stress, attention, and arousal.

A strong focus is on the psychobiology of stress. We encourage studies to determine the neurochemical and behavioral consequences of stress and how to regulate the stress response.

We give high priority to investigations that rigorously examine the behavioral consequences of neurochemical regulation. We accept proposals for neurobiological research that does not study behavior but that would clearly further understanding of behavior. We rarely support applied studies of human performance.

In conjunction with other programs described in this brochure, the neuroscience program may support neurobiological research on visual and auditory information processing, multisensory integration, and higher cognitive functions.

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Chronobiology

The objective of the chronobiology program is to elucidate the biological mechanisms responsible for circadian rhythmicity and how they influence behavior relevant to skilled human performance. We seek proposals on the location and function of circadian pacemakers; mechanisms by which pacemakers such as the suprachiasmatic nucleus are entrained or reset; and the sensory, motor, and cognitive manifestations of circadian activity. Experimental approaches involving lesion studies, neurochemistry, molecular biology, neurophysiology, pharmacology, and behavior will address how the circadian timing system is regulated. Studies with vertebrates are of most interest. Reproductive studies will not be considered.

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Perception and Recognition

This program primarily supports visual and auditory psychophysical research on human adults. The primary objective is to discover and quantitatively model feature processing mechanisms underlying sensory pattern perception and recognition. We encourage multidisciplinary research, particularly if the results can be constrained by behavioral data. Collaboration between psychophysicists and scientists in other disciplines is often valuable. Theoretical efforts are most welcome.

The program currently supports theoretical and experimental work on topics related to featural processing and pattern classification, including the visual mechanisms of contrast detection and discrimination, motion, eye movements, color, and stereopsis, as well as auditory mechanisms that underlie recognition, pitch, localization, and speech. We will consider research on other sensory modalities.

We also support theory and modeling of neural circuitry in the sensory and sensorimotor pathways of biological systems, primarily in higher vertebrates. Multidisciplinary approaches, as well as models and simulations of the dynamic behavior of neuroanatomically distinct regions, are especially emphasized.

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Spatial Orientation

This program encourages research into human behavior and theory concerning perceived location and movement through space. Research is especially encouraged to identify and model the sensory and sensorimotor mechanisms that process environmental cues from single and multiple sensory sources. We will consider both theoretical and experimental work.

Theoretical approaches may include analytic and computational models that attempt to explain performance, preferably in terms of underlying neural processes. Experimental approaches may include human or animal studies, but those leading more directly to models of human performance will be emphasized.

Proposals are considered for work on the following and other related topics: visual orientation and posture, auditory localization, vestibular and proprioceptive perception of movement, multisensory integrative mechanisms, simple sensorimotor behaviors (e.g., ballistic movement), and adaptation.

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Cognition

This program supports basic research on cognitive processes, particularly cognitive aspects of attention, memory, information processing, learning, reasoning, problem solving, and decision making under stress. The study of these topics under complex conditions of high workload is especially appropriate.

The goal of the program is to support theoretical and experimental research that illuminates the fundamental mechanisms underlying human performance. We support research using behavioral methods alone or a combination of behavioral and biological or computational methods.

Two special programs provide for collaboration with Air Force laboratory scientists:

(1) *Center for Learning Ability*

This program provides awards for collaboration with scientists at the Armstrong Laboratory, a large test facility for research on individual differences in cognitive ability. This unique facility includes 30 test stations with microcomputers and associated equipment and a mainframe computer for reducing data. Several hundred new subjects are available for testing each week. One current research project measures individual differences in processing speed and working memory capacity to predict learning performance. Proposers are encouraged to describe other studies related to individual differences in learning ability. Awards will support visits to this facility for collaborative research.

(2) *Intelligent Teaching*

This program supports collaboration with scientists at the Armstrong Laboratory to develop theory-based automated instructional techniques. A laboratory of flexible microcomputer-based training delivery systems is available for investigations of training strategies using large samples of subjects.

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Bioenvironmental Sciences

Air Force operations involve chemical and physical agents that are potentially harmful to Air Force personnel, the surrounding populace, and the environment. These agents include fuel components, lubricants, solvents, and aerospace materials. (A list of chemicals is available on request.) An understanding of the fundamental interactions of potentially hazardous agents with biological systems and the underlying mechanisms of action is essential to protect humans and the environment.

We support fundamental research in two main areas:

1. The mechanistic toxicology program supports research on:

a) mechanisms of toxicity of specific Air Force chemicals, chemical classes, and physical agents,

b) structure-activity relationships,

c) molecular mechanisms of toxicity common among chemical and physical agents (e.g., free radicals and dioxide intermediates), and

d) pharmacokinetic models of the toxic effects of Air Force-associated chemicals and chemical classes.

2. The environmental toxicology program supports research on:

a) interactions of chemicals with living organisms; relevant biotic-abiotic relationships,

b) biodegradation and detoxification,

c) identification of exposure routes; mechanisms for reducing or blocking uptake; and biosynthesis of intermediates, and

d) fate and effects of contaminants and metabolites on biosystems, communities, and ecosystems.

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Terrestrial Sciences

The goal of this research program is to increase our knowledge of the Earth's structure and its dynamics. The need to monitor nuclear treaties and the stringent accuracy requirements of missiles motivate this research, primarily in seismology, geodesy, and gravity.

Research in seismology is required to improve our capability to monitor nuclear treaties. It is also needed to determine the effects of ground motion from earthquakes, explosions, and natural or artificial seismic energy sources. Research in gravity is necessary to determine its effect on missile guidance systems along flight paths.

A major area of interest in seismology is improving the fundamental understanding of the physical characteristics of the generation and propagation of regional and teleseismic waves, along with the application of this understanding to nuclear test verification, with particular

emphasis on discrimination between low-yield events, natural phenomena, and industrial chemical explosions. We are interested in developing accurate techniques to measure gravity (for example, gravity gradiometers) and to interpret gravity data. We also seek analytical and instrumental techniques to measure the Earth's dynamic motions accurately over a wide range of frequencies. A balanced program involving theoretical and laboratory studies, including well-formulated field experiments that address fundamental geophysical problems, is desired.

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Meteorology

A fundamental understanding of the physics underlying weather and climate is essential for improving our capability to support strategic and tactical military readiness.

We are interested in innovative research proposals that seek to illuminate the dynamic distribution of energy among large, medium, and small scales of atmospheric motion and the nature of relationships between cloud processes and large motion scales. While we recognize that measurements and measurement techniques are important in the research, we currently place a higher priority on efforts to extract the underlying physics rather than proposals that concentrate on gathering data.

We assign highest priority to research ideas in mesoscale dynamics and predictions; physics and dynamics of precipitation systems; cloud microphysics; boundary layer dynamics; atmospheric electricity; and satelite and radar meteorology, including the development of new remote measurement techniques and analytical techniques for extracting meteorological data.

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Ionospheric Research

Our research goal is to define the physical and chemical properties of the Earth's upper atmosphere and ionosphere and to determine effects of these properties on Air Force systems operating in or through these regions.

Our main interests are understanding the structure and chemistry of the upper atmosphere and the physics and dynamics of the ionospheric region. This effort includes modeling atmospheric tides, solar radiation, high-energy particles, magnetospheric disturbances and their effects on ionospheric dynamics, and electron density structure.

While we recognize that measurements and measurement techniques play an important role in this area, we are convinced that significant progress will require programs that carefully combine theory with experiment. In the near term, we will emphasize analyzing information to extract the fundamental physics rather than gathering data.

We place the highest priorites on research in ionospheric distrubances; ionospheric physics; plasma turbulence and dynamics; ionospheric-magnetospheric coupling; and ion/neutral structure, chemistry, and transport mechanisms.

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Optical and Infrared Environment

Research is directed toward understanding the atmospheric processes that could influence design and operation of communication, navigation, surveillance, and weapons systems operating in the optical and infrared to millimeter wavelengths.

Our interest centers on creative research leading to new knowledge of the physical processes controlling optical and infrared emissions in the quiescent atmosphere and of processes caused by natural auroral or nuclear-detonation disturbances.

Our highest priorities are research ideas in auroral or nuclear backgrounds, atmospheric transmission and absorption, natural airglow, and optical aerosols. Other topics of interest include remote sensing of atmospheric quantities, theoretical studies of molecular parameters, and coherence effects in spectroscopy.

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Space Sciences

The effects of electromagnetic radiation, charged atomic particles, and electric and magnetic fields can endanger the mission and degrade the performance of Air Force systems operating in near-Earth space. Both the ambient and the disturbed space environment can disrupt the detection and tracking of missiles and satellites, distort communications, and interfere with surveillance operations.

This research provides basic knowledge of the space environment for the design and calibration of Air Force systems operating in and through space. Experimental and theoretical methods are used to study the following:

1. Solar activity.
2. Solar outbursts and their travel from the Sun to the Earth.

3. The particle and field composition of the space environment, especially the magnetosphere.

4. Changes in this environment caused by natural and artificial disturbances.

5. The response of spacecraft systems and operations to conditions in space.

6. The celestial background and its temporal, spatial, and spectral variations.

Current topics of interest include the following:

1. Developing a capability to forecast solar activity, such as by identifying phenomena on the Sun and in interplanetary space that are associated with perturbations of the aerospace environment.

2. Investigating the production and transport of magnetospheric plasma to understand geomagnetic storm phenomena and to predict the expected charged particle distributions encountered by Air Force spacecraft.

3. Developing models to simulate wave modes generated during injection of artificial beams into space plasmas.

4. Understanding celestial background radiation and developing novel techniques to improve space surveillance systems.

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MATHEMATICAL AND COMPUTER SCIENCES

Dynamics and Control, Dr. Jacobs
Physical Mathematics, Dr. Nachman
Computational Mathematics, Dr. Jacobs
Optimization and Discrete Mathematics, Dr. Glassman
Signal Processing, Probability, and Statistics, Dr. Sjogren
Software and Systems, Lt. Col. Lupo
Artificial Intelligence, Dr. Waksman
Neural Computation Systems, Capt. Suddarth
Electromagnetics, Dr. Nachman

The Directorate of Mathematical and Computer Sciences sponsors extramural research programs in the areas described in this section. In addition, the Air Force laboratories perform complementary in-house basic research in specific areas. For example, the Wright Laboratory (at Wright-Patterson Air Force Base) and the Phillips Laboratory (at Edwards Air Force Base) engage in basic research in guidance and control. The Phillips Laboratory (at Kirtland Air Force Base and Hanscom Air Force Base) performs basic research in computational mathematics and parallel processing. The Wright Laboratory (at Wright-Patterson Air Force Base) also engages in basic research in electronic prototyping, neural networks, and dynamical systems. The Rome Laboratory at Griffiss Air Force Base performs basic research in signal processing and software and systems, and at Hanscom Air Force Base it performs basic research in electromagnetics. The Phillips Laboratory (at Kirtland Air Force Base) performs basic research in imaging.

Dynamics and Control

Research in this program leads to improved techniques in the design and analysis of new control systems with enhanced capabilities and performance for use in future Air Force missions. Applications include the development of robust feedback controllers for advanced high-performance aircraft and adaptive, reconfigurable flight control systems; control of vibrations and the shape of large, flexible space structures; active control of wing camber using imbedded smart sensors and actuators; control of combustion and fluid flow processes associated with aerospace vehicles; control of electromagnetic radiation by controlling the properties of a propagating surface; and novel hierarchical control systems that can intelligently manage actuator, sensor, and processor communications in complex systems. We emphasize research in distributed-parameter control (including control of complex coupled fluid/structure systems), robust multivariable feedback control for both linear and nonlinear systems, and, to a lesser degree, fundamental applied research in adaptive and stochastic control, design optimization, control of discrete event dynamical systems, and use of neural networks for control design.

Research in robust multivariable feedback control will develop mathematical methods that allow the design and analysis of feedback systems that achieve stability and satisfy other performance objectives in the face of model uncertainties. There is special interest in the development of a theory of robust control for nonlinear and distributed parameter systems and in novel approaches to effective robust-control-oriented system identification techniques.

Distributed parameter control problems involve systems with dynamics given by partial differential equations, integro-differential equations, or equations with delays. New integrated approaches are needed to develop approximation techniques for the identification, control, and optimization of distributed parameter systems. While efforts continue in dynamics and control theory for flexible structures, increased attention is focused on mathematical techniques that support the development of modern control theory applicable to controlling fluid flow and combustion processes, as well as complex, highly nonlinear coupled interactions between structural deformation and unsteady flows. These research efforts are coordinated with ongoing efforts in aerospace engineering that emphasize experimental research.

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Physical Mathematics

This program pursues mathematical models and their analysis in areas of interest to the Air Force. Our goal is to distill focused mathematical models of particular physical phenomena and the mathematical methods for their analysis, as well as to produce models sufficient for numerical computation. The payoffs include understanding and modeling physical phenomena such as nonlinear optics or turbulent flow, leading to methods for their simulation and control.

While supporting a broad range of topics, this program concentrates on several special interests: nonlinear optics, inverse problems (the radar interpretation problem and Non Destructive Evaluation), mathematical materials sciences, and theoretical fluid mechanics (including hypersonics). All of these areas have in common the nonlinearity of their mathematical descriptions. Nonlinear mathematics exhibits a spectrum of behavior for which effective mathematical understanding either is unavailable or is only beginning to emerge. What is striking is the ubiquitous appearance of coherent structures (solitons and their relatives), chaotic solutions, or formation of singularities in many seemingly disparate physical scenarios. Research emphasizes both analytical and numerical tools that tackle these problems.

One goal of nonlinear optics is the effective exploitation of lasers. Solitons, chaos, and other operational possibilities that effect beam control, imaging, and diode array stability are stressed. Research on laser-induced ocular damage involves identification of field filamentation and incipient singularity formation.

Recent work in mathematical material science involves a blend of nonmonotonic constitutive laws and modern variational approaches that attempt to incorporate measure theory and homogenization in a computationally useful way. The inverse-problems area seeks, for example, to deduce the nature of the scatterer from the waves it scatters back to the observer. The emphasis here

is to confront scenarios in which the Born approximation and its obvious extensions are inapplicable.

Research in hypersonics could seek to include real gas effects and rarified flow regimes. Nonlinear stability, important distinguished limits, and clarification of unresolved issues in noncontinuum models are some areas of interest.

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Computational Mathematics

This program aims to develop improved mathematical methods and algorithms to utilize advanced computational capabilities to support the scientific computing interests of the Air Force. For the most part, this effort concentrates on supporting the development of innovative methods and algorithms that enable the improved modeling, simulation, understanding, and control of complex physical phenomena of interest to the Air Force. These phenomena include fluid flow, combustion processes, control of flexible space structures, nonlinear optics, directed energy weapons, high-energy-density materials, crystal growth, weather modeling, and high-power microwaves. Our research also supports the national agenda in high-performance computing.

We are developing numerical methods and algorithms to fully exploit the potential of parallel computing for fast, accurate numerical solution of complex systems occurring both in engineering design of Air Force systems and in operations. Efficient use of available parallel machines requires that we pay increased attention to dynamic resource allocation and load balancing, domain decomposition techniques, scalable parallel algorithms, adaptive meshing for shock tracking, and parallel schemes for adaptive grid generation. As the cost of hardware continues to decrease, the results of this program may affect the design of specialized architectures for solving critical scientific problems.

Typically the computational models in this program rely on some numerical scheme that implements a discretization of continuum mechanics equations—generally partial differential equations—that represent the physics of the situation. However, alternative computational models may be appropriate for many problems. We are investigating both traditional and radical approaches in this program. We are developing and improving a variety of numerical methods improved in this subarea, including homogenization techniques, continuation methods, finite elements, particle and vortex methods, finite difference methods, essentially non-oscillatory methods (ENO), and spectral methods. In addition, fast, accurate, and robust methods for solving large systems of linear equations lie at the heart of many scientific computing problems of interest to the Air Force. For this reason, computational linear algebra, especially multilevel or multigrid techniques, continues to receive attention. This emphasis is, however, diminishing.

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Optimization and Discrete Mathematics

Our goal is to develop mathematical methods for solving large or complex problems, such as those occurring in logistics, engineering design, or strategic planning. These problems can often be formulated as mathematical programs. Therefore, research is directed at linear and nonlinear programming methods, especially those that can be implemented on parallel computers. We are also emphasizing discrete structures, as they often represent important Air Force problems.

Three areas of particular importance are emphasized in discrete mathematics. The first is the optimal solution of integer programming models and other combinatorially based structures. These structures arise in areas of interest to the Air Force, such as design of very large-scale integrated (VLSI) networks, frequency assignment, and scheduling and routing. Second, in addition to the evolution of traditional solution methods, the program supports new algorithmic paradigms such as simulated annealing and genetic algorithms. Third, we are beginning a program of research in computational geometry, especially as it relates to electronic prototyping.

Research in optimization focuses on the development of special algorithms for the particular structures that arise, emphasizing implementation on parallel architectures. Since networks are so important for military logistics problems, optimization over networks is a major component of our program. Some research on stochastic optimization, which will benefit from increased parallelism, will begin. We also expect to begin research on the use of nonlinear programming for the optimization of polymers and biomolecules.

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Signal Processing, Probability, and Statistics

This research activity is aimed at the foundations and applications of data collection and interpretation. Digital-based and analog processing of signals is of special significance to the Air Force. Many of the data available for tracking and reconnaisance and for surveil-

lance and communications are carried by an electromagnetic medium. Modern radar, infrared, and other electro-optical sensing systems interpret and act on data that are obtained in massive quantities from multiple sources. Statistical research into spatial and temporal dependencies and their effects will be undertaken to minimize the cost and complexity of fulfilling this essential function.

The Air Force needs support in analyzing and interpreting data for logistical and personnel management. Reliability analysis techniques are pivotal in ensuring that complex Air Force systems are dependable. Research into statistical methods will support more accurate modeling of the behavior of components and entire systems and is necessary for the development of effective maintenance strategies. Concepts leading to more realistic and robust models, involving dependent components or imperfect repair, are essential to a system integration capability and will receive emphasis.

In signal processing, some outstanding issues are how to develop robust algorithms for data compression, image reconstruction, and spectrum estimation in the presence of noise. Characterization of non-Gaussian environments is of special interest, with applications to the key areas of high-speed data communications and enhanced image processing. We will give high priority to investigation of innovative mathematical tools such as "wavelet" and related transforms, with a view toward their potential in detecting transient phenomena in noisy signals, synthesizing hard-to-intercept communications links, achieving high rates of data and image compression, and rapidly performing discrimination and identification on features of interest.

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Software and Systems

The goal of this research effort is to develop advanced information processing capabilities needed to support future Air Force needs in areas such as command, control, communications, and intelligence (C3I), avionics, logistics, and engineering design. The primary research emphasis is on software. Research focuses on, but is not limited to, the development of formal methods for software design specification, implementation, and maintenance. Especially needed are methods that can scale to the complexity of Air Force applications and can offer at least an order of magnitude performance improvement. Applications to embedded parallel and distributed architectures are emphasized.

In particular, a major thrust has been established in distributed computing for C3I. The objective is to enable the confident construction (design and implementation) and maintenance (evolution and upgrading) of distributed, heterogeneous computing systems for C3I. These critical systems continue to pose research challenges in meeting the simultaneous constraints of real time (or deadline-driven) response, fault tolerance including survivability, and security in stochastic environments. This research program will consist of four major components. First, formal methods for specification, analysis, and verification of distributed systems design will receive emphasis. These foundational issues include accurate models of distributed time, dependability, specification languages, and automated analysis tools that can be used to predict design decisions. The second promising component involves theoretical and empirical investigations of distributed object-oriented systems design and construction. Although this paradigm appears to have significant advantages over conventional distributed systems approaches, research on object-oriented design has not yet discovered the appropriate granularity of objects and how operating systems should allocate resources to objects and objects to resources, particularly in deadline-driven environments. The third component focuses on the diverse issues associated with the spectrum of communication scenarios that are anticipated in pre- and post-degraded operations on the battlefield of the future. It is important to discover the most effective ways to exploit future high-performance communications and simultaneously address the achievement of objectives under seriously degraded situations. Several important topics to be examined are interprocessor communications mechanisms, multimedia data, adaptive routing protocols, and atomicity and granularity of messages. To connect these three research components, the fourth component concentrates on design environments for developing robust distributed C3I systems. Among the major research issues are user-friendly versions of the formal techniques, visualizations tools, and simulation methodologies to test fault tolerance.

A separate component of this effort is the development of parallel algorithms, paradigms, and software environments to investigate the use of new parallel architectures in solving engineering design problems. Research topics include architecture-independent programming paradigms and visualization tools for performance analysis and debugging.

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Artificial Intelligence

The goal of artificial intelligence research is to support the emulation and enhancement of intellectual skills within automated systems. We emphasize fundamental research that will facilitate the embedding of artificial intelligence components within Air Force

systems. Research support is concentrated in the areas of resource-bound computation, intelligent management and integration of information, integration of numeric and symbolic computing, vision and image understanding, and management of uncertainty.

A primary focus of our research is to investigate the extension of artificial intelligence reasoning techniques to include the likely scenario of time-constrained decisionmaking under incomplete, corrupt, or dynamically changing information patterns. Research in numeric and symbolic computing addresses the merging of inference techniques of symbolic processing with statistical inference methods. Other critical issues are at the interface between sensory information and its interpretation by symbolic procedures.

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Neural Computation Systems

This program focuses on building brainlike computers that are applicable to smart munitions, pilot assistance, surveillance, high-agility robotics, and intelligent logistics. The research uses biological principles of signal processing and organization to perform computation. Neural processing models offer a significant opportunity to exploit new kinds of highly parallel very large-scale integrated (VLSI) hardware that will be made possible by wafer-scale integration, nanoelectronics, and superconducting circuits. Neural circuits consist of a large number (potentially millions) of simple neuron-like processors placed together in complex networks. These networks can be trained to model relationships based on experience, and they can generalize upon this experience to handle novel situations.

This program develops and characterizes neural models in order to improve training and generalization ability. Another goal is to enlarge the set of problems that can be solved using neural computation. Of particular interest is a new research initiative on systems of coupled oscillators and their use to perform Turing-like computation. Another research initiative investigates the use of neural networks for forming beams in systems such as phased-arrays and adpative optical telescopes. Ultimately, these technologies are targeted for implementation in hardware systems that can learn from examples and compute at very high speed.

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Electromagnetics

This program focuses on state-of-the-art antenna systems for communications, radar, and propagation. Basic electromagnetic radiator research focuses on improvements in efficiency, radiation pattern control, effective bandwidth, impedance matching, radar cross-section, and propagation through dispersive and random media. Unconventional propagation research focuses on radio wave propagation through ionospheric media such as high-frequency ducts. This research is also concerned with the use of particle beams to generate high-frequency waves for use in communication. Scattering research seeks to characterize and exploit the radar cross-section characteristics of both targets and terrain. Future research may also include models for the control of adaptive nonperiodically spaced phased arrays and three-dimensional algorithms for scattering by large objects.

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III

Education, Academic, and Industry Affairs

United States Air Force (USAF)/National Research Council Resident Research Associateship (NRC-RRA) Program

The USAF/NRC-RRA Program offers postdoctoral scientists and engineers opportunities to research problems of their own choosing that are compatible with the research interests of selected sponsoring Air Force laboratories. In this way, these researchers contribute to the overall research effort of the laboratories. The program is intended to be analogous to fellowships, associateships, and similar temporary programs at the doctoral level in universities and other organizations.

The objectives of the program are (1) to provide postdoctoral scientists and engineers of unusual promise and ability opportunities for research on problems, largely of their own choice, that are compatible with the interests of the sponsoring laboratories, and (2) to contribute to the overall efforts of the Federal laboratories.

Postdoctoral Research Associateships are awarded to U.S. citizens and permanent residents who have held doctorates fewer than 5 years at the time of application. They are made initially for 1 year.

Visting Fellow Research Associateships are awarded to individuals who have held a doctorate for 5 or more years, are qualified citizens of the United States, or are citizens of other countries who have full command of the English language. Applicants should have research experience that has resulted in significant contributions and be recognized as internationally known experts in their specialized fields, as evidenced by numerous publications in reviewed journals, invited presentations, authorship of books or book chapters, professional society awards of international stature, etc. Although awards to Visiting Fellow Associates are usually for 1 year, awards for periods of 3 months or longer will be considered.

Postdoctoral Research Associates receive a stipend from the NRC while carrying out their proposed research. The annual stipend for a Postdoctoral Associate is $39,000 with additional increments for each year past the Ph.D. An appropriately higher stipend is offered to Visiting Fellow Associates.

Awardees also receive a relocation reimbursement and funds for limited professional travel, if the research advisor recommends the travel and the NRC approves it in advance. Funding is normally provided for approximately 36 associates each year.

For additional information, write—

Associateship Programs (GF424)
National Research Council
2101 Constitution Avenue, NW
Washington, DC 20418
(202) 334-2760

University Resident Research Program (URRP)

The URRP enables highly qualified university faculty members to spend 1 year, or 2 years with an extension, at Air Force laboratories working on research problems of interest to the Air Force. Through this program faculty members can use their expertise to contribute fresh ideas to Air Force research. The Air Force Office of Scientific Research (AFOSR) funds and manages the program. Air Force Laboratories furnish the necessary support services, facilities, and equipment for the research. This program is limited to U.S. citizens.

Assignments are for 1 year unless the needs of the Air Force require an extension. The Air Force, the faculty member, and the university must agree to the extension, which will not exceed 1 year.

Participants continue to receive salaries from their universities. AFOSR and the Air Force laboratories negotiate with the university for travel and moving expenses and the amount of the salary needed to cover the time of the sabbatical or leave of absence. AFOSR provides the funds to the Air Force laboratory at which the research is done. The laboratory then reimburses the university for the assignee's salary and for the university's contribution to basic fringe benefits, such as health and life insurance, retirement, and Social Security.

An endorsement from the laboratory chief scientist is required before a candidate's application can be reviewed at AFOSR. Appointees have the status of visiting scientists or engineers in the laboratory and are subject to the general conditions of the laboratory. The date on which appointments begin, which may be any time during the year, are negotiated with the appointees.

For more information, write—

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Summer Faculty Research Program (SFRP)

The SFRP provides research opportunities for qualified faculty members of U.S. colleges and universities at Air Force research facilities within the continental United States. The objectives of SFRP are to:

1. develop the basis for continuing research of interest to the Air Force at the faculty member's institution,

2. stimulate continuing relations among faculty members and their professional peers in the Air Force, and

3. enhance the research interests and capabilities of scientific engineering educators in scientific areas of interest to the Air Force.

University faculty members spend 8 to 12 weeks during the summer working at an Air Force research activity. To qualify, applicants must:

1. be U.S. citizens or permanent residents,
2. be faculty members of an accredited U.S. college, university, or technical institute, and
3. have at least 2 years of teaching and/or research experience.

After completing this program, participants may submit a proposal for continuing research at their own facilities. Selected proposals are funded under the Research Initiation Program (RIP).

For regular summer appointments, the research is conducted for a continuous period of 8 to 12 weeks between April 1 and September 30; the start date is flexible. Under exceptional circumstances, the Air Force Office of Scientific Research (AFOSR), a Summer Faculty Researcher, and the Air Force laboratory may arrange a research appointment during October through March.

For the research period, each Fellow receives about $745 a week, an expense allowance of about $50 a day, and a travel allowance to cover the cost of traveling to and from the Air Force research site. AFOSR Fellows may visit the research sites before the research period by writing the laboratory representative ahead of time.

For more information, write—

Research and Development Laboratories
Summer Research Program Office
5800 Uplander Way
Culver City, CA 90230-6608
(800) 677-1363
or
Lt. Col. Claude Cavender
AFOSR/NI
Bolling AFB, DC 20332-6448
(202) 767-4970; DSN: 297-4970

Summer Faculty Research Program/ Summer Research Extension Program (SFRP/SREP)

After completing the SFRP, participants may submit proposals to continue the research at their universities. These proposals, if accepted, are funded under the SFRP/RIP. To compete for a SFRP/RIP award, SFRP participants must submit a complete proposal and proposed budget either during or promptly after their SFRP appointment.

Each proposal is evaluated for technical excellence, with special emphasis on relevance to continuation of the SFRP effort as determined by the Air Force laboratory or center.

The maximum award under the SFRP/RIP is $20,000 plus the amount shared by the employing institution. Employing institutions are encouraged to cost-share because the SFRP/RIP is designed only to initiate research. The total available funds limit the number of awards. Historically, about half the SFRP participants receive SFRP/RIP awards.

Proposal deadline is November 1. Funded projects start no earlier than September 1 and end no later than December 15 of the following year.

For more information, write—

Research and Development Laboratories
Summer Research Program Office
5800 Uplander Way
Culver City, CA 90230-6608
(800) 677-1363
or
Lt. Col. Claude Cavender
AFOSR/NI
Bolling AFB, DC 20332-6448
(202) 767-4970; DSN: 297-4970

Graduate Student Research Program (GSRP)

GSRP is an adjunct effort of the Summer Faculty Research Program (SFRP). The program provides research funds for selected graduate students to work at appropriate Air Force facilities with supervising professors who hold an SFRP appointment or with designated laboratory researchers. The objectives of GSRP are to:

1. provide a productive means for a graduate student to participate in research under the direction of a faculty member or researcher at an Air Force laboratory,
2. stimulate continuing professional association among graduate students, their supervising professors, and professional peers in the Air Force, and
3. expose graduate students to potential thesis topics in areas of interest to the Air Force.

To qualify as a Graduate Researcher in GSRP, applicants must be:

1. U.S. citizens,
2. holders of either a B.S. or M.S. degree in the appropriate technical specialty,
3. registered in a graduate school program working toward an appropriate graduate degree at their respective institutions, and
4. willing to pursue their summer research work under the direction of a supervising professor who holds an appointment under SFRP or a designated laboratory researcher.

The period is a continuous period of 8 to 12 weeks between April 1 and September 30. The student's research period should coincide with the appointment time of the supervising professor.

A selectee receives a predetermined stipend based on educational level. Holders of a B.S. degree receive about $395 per week; holders of an M.S. degree receive

about $455 per week. In addition, a daily expense allowance of about $35 is paid for each day the researcher spends at the Air Force location. A travel allowance is also included to cover the cost of traveling to and from the Air Force research site.

For more information, write—

Research and Development Laboratories
Summer Research Program Office
5800 Uplander Way
Culver City, CA 90230-6608
(800) 677-1363
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Bolling AFB, DC 20332-6448
(202) 767-4970; DSN: 297-4970

Laboratory Graduate Fellowship Program (LGFP)

As a means of increasing the number of U.S. citizens obtaining Ph.D. degrees in science and engineering, the Air Force Office of Scientific Research (AFOSR) annually offers about 25 three-year fellowships. These fellowships are for study and research in areas of interest to the Air Force. Fellowships are limited to U.S. citizens who have received their baccalaureate degrees. Air Force laboratory graduate fellowships are tenable at any U.S. institution of higher education offering a Ph.D. in science or engineering.

Fellows receive stipends of $15,000 the first year, $16,000 the second year, and $17,000 the third year. Stipends are prorated for fellowship periods of fewer than 12 months; however, the duration of the fellowship will not be for fewer than 9 months. In addition to the stipend, the Air Force pays the Fellow's institution's full tuition and fees and provides $2,000 per year to the Fellow's department.

Each Fellow is sponsored by an Air Force laboratory that assigns a mentor to the student. Fellows are reqired to perform research at their sponsoring Air Force laboratory for at least one summer period in their first or second year of the fellowship. Eighty-three Fellows received support in Fiscal Year 1992.

For more information, write—

Southeastern Center for Electrical
Engineering Education (SCEEE)
1101 Massachusetts Avenue
St. Cloud, FL 34769
(407) 892-6146
or
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Bolling AFB, DC 20332-6448
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National Defense Science and Engineering Graduate (NDSEG) Fellowship Program

The NDSEG Fellowship Program is a Department of Defense (DOD) fellowship program sponsored by the Air Force Office of Scientific Research, the Army Research Office, the Office of Naval Research, and the Defense Advanced Research Projects Agency. The eligibility requirements and stipends paid, including tuition and fees, are the same as the Air Force Laboratory Graduate Fellowship Program (LGFP). The DOD selects about 100 Fellows per year; the Air Force sponsors about 25 of the Fellows.

Ten percent of these awards will be set aside for applicants who are members of an ethnic minority group underrepresented in the advanced levels of the U.S. science and engineering personnel pool, i.e., American Indian, Black, Hispanic, Native Alaskan (Eskimo, Aleut), or Native Pacific Islander (Polynesian or Micronesian).

Those Fellows selected and sponsored by the Air Force will be offered the opportunity to become associated with an Air Force laboratory but are not required to spend a summer at an Air Force laboratory.

For more information, write—

NDSEG Fellowship Program
Battelle
200 Park Drive, Suite 211
P.O. Box 13444
Research Triangle Park, NC 27709
(919) 549-8505
or
Lt. Col. Claude Cavender
AFOSR/NI
Bolling AFB, DC 20332-6448
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Advanced Thermionic Research Initiative (ATRI)

ATRI's purpose is to advance the knowledge and technology necessary for realizing the next generation of microwave and millimeter wave thermionic amplifiers and components. The approach consists of a multidisciplinary education and research program for new thermionic engineers and scientists leading to an M.S. and/or Ph.D. degree.

This program, originally called Air Force Thermionic Engineering Research (AFTER), was begun in 1977 at Stanford University and then transferred to the University of Utah in 1981. Since fall 1987 the program has resided at the University of California-Los Angeles. Professor Neville C. Luhmann, Jr., Electrical Engineering Department, UCLA, heads the program. The program is cosponsored by Hughes Aircraft Co.; Litton Industries; Northrop Corp.; Teledyne MEC; Varian Associates, Inc.; and Stanford Linear Accelerator (SLAC).

Fellowships are available for graduate study and research in amounts up to $20,000 per year.

U.S. citizens with B.S. degrees in electrical engineering may apply. Selection is subject to the admissions requirements of UCLA. Thesis topics are cleared through the ATRI Advisory Board, which consists of representatives from UCLA, industry, and the Air Force.

For more information, contact—

Professor N.C. Luhmann, Jr.
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Electrical Engineering Department
University of California
Los Angeles, CA 90024-1594
(213) 825-3209
or
Dr. Edward Daniszewski
RL/OCTP Griffiss AFB, NY 13441-5700
(315) 330-4381; DSN: 587-4381

IV

Directory

Organizational Directory

ORGANIZATION	ADDRESS	NAME AND TELEPHONE NUMBER
Air Force Office of Scientific Research (AFOSR)	AFOSR Bolling AFB, DC 20332–6448	Hellwig, Helmut, Dr. Director (202) 767–5017; DSN: 297–5017; FAX: (202) 767–6213 Pavel, Arthur, Col. Deputy Director (202) 767–5018; DSN: 297–5018; FAX: (202) 767–6213
Contracts Directorate	AFOSR/PK	Hawkins, Ed, Director (202) 767–4945; DSN: 297–4945; FAX: (202) 404–7951
Aerospace Sciences Directorate	AFOSR/NA	Chang, Jim C. I., Dr. Director (202) 767–4987; DSN: 297–4987; FAX: (202) 767–4988
Chemistry and Materials Sciences Directorate	AFOSR/NC	Ball, Donald L., Dr. Director (202) 767–4960; DSN: 297–4960; FAX: (202) 767–4961
Physics and Electronics Directorate	AFOSR/NE	Wittmann, Horst R., Dr. Director (202) 767–4984; DSN: 297–4984; FAX: (202) 767–4986
Life and Environmental Sciences Directorate	AFOSR/NL	Berry, William O., Dr. Director (202) 767–4278; DSN: 297–4278; FAX: (202) 404–7475
Mathematical and Computer Sciences Directorate	AFOSR/NM	Holland, Charles J., Dr. Director (202) 767–5025; DSN: 297–5025; FAX: (202) 404–7475
Education, Academic & Industry Affairs Directorate	AFOSR/NI	Rhoads, Harold S., Col. Director (202) 767–4969; DSN: 297–4969; FAX: (202) 767–5012
European Office of Aerospace Research and Development	EOARD/CC 223/231 Old Marylebone Rd. London NW15th United Kingdom EOARD, Box 14 PSC FPO, AE 09499–0200	Crimmel, William W., Col. Commander (01) 44–71–409–4376; DSN: 235–4505; FAX: (01) 44–71–402–9618
Frank J. Seiler Research Laboratory (FJSRL)	FJSRL/CC, U.S. Air Force Academy CO 80840–6528	Morgan, Barry, Lt. Col. Commander (719) 472–2655; DSN: 259–2655; FAX: (719) 472–3649
Asian Office of Aerospace Research and Development (AOARD)	AOARD APO AP 96337–0007	Fujishiro, Shiro, Dr. Director 81–03–5401–4409; DSN: 785–1301; FAX: 81–03–5410–4407

(DSN numbers are available only on Department of Defense telephones.)

Due to the recent restructuring of the Air Force Laboratories, this preliminary list is subject to change.

Armstrong Laboratory	AL/CA Brooks AFB TX 78235–5000	Mohr, George, Dr. Chief Scientist (512) 536–3656; DSN: 240–3656; FAX: (512) 536–2371
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